GLOBALISATION, CONCENTRATION OF GENETIC MATERIAL AND THEIR IMPLICATIONS FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

This paper examines impacts, both positive and negative, of globalisation on the selection of a limited gene pool in livestock and agricultural production. This concentration has increased yields at high rates. It is associated with modern forms of production that are an integral part of a globalised economic system. Such strategies, at least in the short run, reduce production costs and cater for the demands of an increasing population and the needs of modern societies. As will be demonstrated, the ascribed economic benefits of such forms of production also lead to the promotion of such production by donor agencies and are linked to overseas aid, in some instances. On the other hand, specialised systems of production are not without their drawbacks. Such systems of production make many breeds (eg. 'all-round' breeds) obsolete for commercial use. This often leads to their gradual extinction because of the low economic values placed on them. When concentration of production relies on a few breeds it inevitably leads to several lock-in dimensions in the use of some production inputs. The lock-in aspects of this form of production, processes involved in the disappearance of breeds and their implications for sustainable development are amongst the issues discussed in this paper.

1. INTRODUCTION

Economic globalisation has brought about huge increases in world production by encouraging greater specialisation in production as a result of growing possibilities for exchange of production regionally and otherwise. This has occurred not only in industrial production but also in the agricultural sector, including livestock (FAO, 2000). Specialisation in production is an inevitable process as firms/producers aim to minimise their costs of production and maximise their gains. This process has not only lowered costs which have made produce more affordable to consumers but has also made production more accessible. This development has helped to feed the increased global population and perhaps has averted a Malthusian food crisis. The key feature of such production systems has been their increasing concentration of producers on a very limited gene pool that yields very high returns (FAO, 2000). For example, in livestock production, breeds that are comparatively more efficient in producing large quantities of one item rather than many items at the same time are preferred according to the specialised system of production. For instance, breeds that are comparatively more efficient in producing milk or meat, or eggs become the preferred choice than the 'all-round' breeds which are the preferred choice in production systems that do not produce on a large-scale such as in semi-subsistence economies or economies that do not engage in large-scale trading (Tisdell et al., 2003). Once specialised breeds are selected for production they undergo further transformation in order to produce even large quantities of the same item through genetic manipulation and development (FAO, 2000). Furthermore, the good or goods produced are customised to meet customer preferences and tastes which further narrows down the genetic material used in production. For example, leaner meat is produced in preference to meat that is more 'fatty' or 'breeds able to deliver standardised products are favoured' (Tisdell, 2003, p.374). These processes in fact could also limit 'choices' available to consumers (Tisdell et. al., 2004).

In such systems, it is not only genetic selection that becomes specialised, but also the various inputs that are used in the production process. In order to maximise the economic outcomes, a system reliant on the provision of specialised conditions or inputs has to be simultaneously provided. Otherwise, the production system may not only under-perform, but is likely to collapse. An example is the introduction of hybrid high yielding rice and wheat varieties to South Asia in the 1960s (Alauddin et al., 1991). In order to reap the benefits of this new technology, specialised inputs such as fertilisers, pesticides and irrigation had to be simultaneously provided. These new systems of production are not foolproof but are susceptible to disease outbreaks, pest infestations and make farmers more dependent on these specialised inputs which are 'externally' provided. As a result 'lock in' aspects, both in the use and of genetic material inputs and systems of production take place. Thus, this process not only limits choice for consumers, but also narrows forms of production. It is also likely that these forms of production/technology are copied/transferred rapidly among producers within countries and between countries. Such technology is often promoted by governments and donor agencies in their quest to promote economic development and progress.

While extension of the market system by encouraging concentration and specialisation of production has brought about large increases in production and fostered technical efficiencies, it is not without its drawbacks. As Tisdell (2003, p.370) points out 'it is a powerful force for loss of genetic diversity'. It can result in several negative externalities which in many cases have gone largely unnoticed. Furthermore, loss of genetic diversity in crops and livestock can have adverse consequences for sustainable development. This is the main theme of this paper. In the first section, forms of agricultural and livestock production for domestic and globalised markets are discussed. The second section involves a case study of globalisation in Vietnam in its pig industry. It explores the short-run economic benefits by concentrating on a limited gene pool using a cost-benefit analysis. The third section deals with the environmental and conservation implications of primary production becoming dependent on a restricted gene pool. Examples involving livestock and agricultural production are given in this section. The final section concludes the paper.

2. FORMS OF AGRICULTURAL AND LIVESTOCK PRODUCTION

Specialisation and concentration have taken place in almost all areas of production and service provision. In the case of industrial production, specialisation and mass production have narrowed forms of production displacing labour in the process. For instance when goods and services began to be manufactured on a large scale it started to displace labour within countries and overseas. Many artisans lost their trades as a result of cheaper commodities competing with the goods produced by them (cf. Dobb, 1967, p.50). While the well documented effects of this production were mainly related to humans and their welfare, concentration/specialisation of production in the agricultural sector has further implications which go largely unnoticed because of the nature of the problem.

In earlier times, before greater specialisation of production, a wider variety of breeds were used than now. For instance, individual producers did not produce on a large-scale such as in semi-subsistence economies or in economies not engaged in large-scale trading and there was an incentive to use ‘all round’ livestock breeds that produced for instance milk, beef, worked on the farm, produced manure and transport. In other words, farmers were mostly self-sufficient and sold only their surplus in the market or traded it for some other commodity. However, market extension favours the selection of specialised breeds and results in the loss of ‘all round’ breeds.

The use of ‘all round’ breeds is a cost in this market-oriented production where specialisation is intensified to produce a larger quantity for a larger market and to maximise profits. Market-oriented production prefers and selects breeds that are not ‘all round’ but those that produce **more of one thing** than three or four items of moderate quantity. Such a scenario, before and after globalisation, is illustrated in Figure 1.

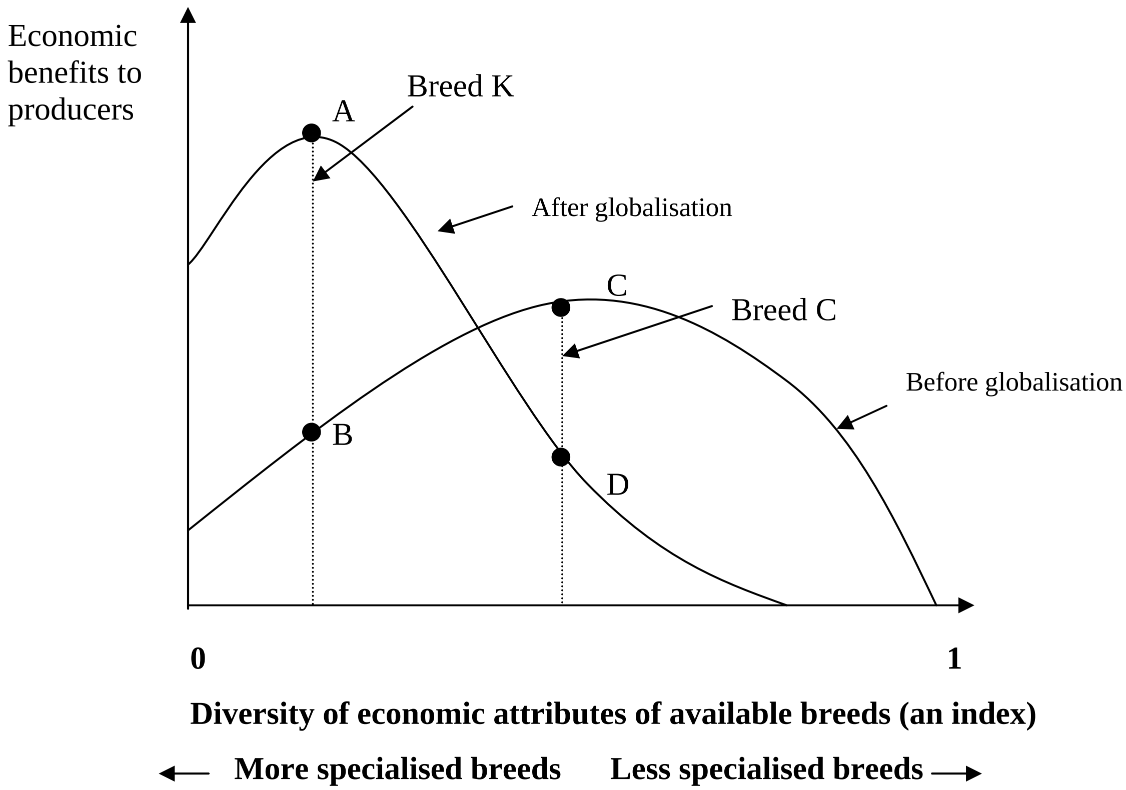

Figure 1: Economic benefits of breeds available to a typical producer before and after globalisation based on different degrees of diversity of economic attributes or characteristics dictated by their genetic make up.

Figure 1 shows the diversity of attributes of breeds available and the economic function of a typical producer **before** and after **globalisation**. The vertical axis shows the economic benefits to producers and the horizontal axis shows the diversity of economic attributes of different breeds that are available for selection in the production process. Those closer to the origin (Figure 1) are breeds that produce largely one or two items efficiently. As we move towards 1 the 'all round' characteristics of breeds become prominent. For instance, at a point close to 1, the 'all round' qualities are so great that they are not considered in commercial production. It must be pointed out that points at 0 and 1 are extreme cases. Those breeds close to 1 are of little interest to commercial producers on a large scale but they are valuable breeds to subsistence or semi-subsistence farmers who depend on such breeds for their livelihoods.

For the hypothetical producer shown in Figure 1, breed C is the preferred one before globalisation. It gives the maximum economic benefits. Breed K is the preferred one after globalisation. Breed C gives an economic benefit to the producer of an amount corresponding to C before globalisation but only an amount corresponding to D after globalisation. The more specialised breeds could provide the producer with an economic benefit corresponding to A after globalisation which was only B before globalisation. In scenarios such as those explained in Figure 1 variety in types of products supplied is not an asset, but a threat to the survival of breeds that display diversity.

As production increases and prices fall specialised breeds displace those of subsistence farmers. The latter are mainly ‘all round’ breeds preferred for their form of production and livelihood. This process accelerates the extinction process. Other factors such as tastes, the demand for leaner meet, availability of storage/refrigeration, foreign aid/technology transfers accelerate the process of specialisation and concentration of production. Other production systems such as the provision of inputs are also developed for such production systems and they place greater reliance on such processes. This has happened in agricultural production systems such as grain (eg. wheat and rice) or livestock production. This results in several ‘lock in’ aspects of production.

In the next section we show how production gets concentrated based on a case study conducted in Vietnam.

3. A CASE STUDY OF ECONOMICS AND GENETIC SELECTION OF PIGS IN VIETNAM

Pigs are an important source of food in Vietnam where it is estimated that 70% of animal protein intake is provided by pork (Tisdell et al., 2001). Pork is a basic part of the diet of the Vietnamese. The population of pigs in Vietnam far exceeds those of buffalo and cattle. In addition to the importance of pigs in Vietnam, one of the objectives of the government is to produce pork for an export market. However, despite these goals and the importance of pigs for the local economy, production and productivity of the pig industry have been low. Hence, during the last ten years it was found to be necessary to bring about genetic improvements in the pig industry along with further research and dissemination of new techniques. As one of the objectives, foreign pig genes were introduced to Vietnam in the 1990s from Belgium and Australia in the form of foreign aid. This introduction has resulted in a substantial rise in pork yields. In addition to the large increases in productivity and production, the quality of Vietnamese pork has increased significantly. Furthermore, the new genes from Australia have helped to reduce stress for the animals during transport, reduce excessive fattiness, improve feed-conversion ratios and bring about higher growth rates. In addition, the size of litters of the new breeds is larger which is an economic advantage because fewer sows have to be kept to produce the same number of slaughter pigs. Alternatively, the saving in the stock of breeding sows can be used to produce extra pigs for slaughter. Hence, pork production can be increased without increasing costs.

All these improvements mean that fewer resources have to be tied up. In other words such production involves reducing costs and reducing market prices while at the same time improving the quality of the product. Farmers adopting such technology stand to profit. Because of these developments the new technology is becoming increasingly popular in Vietnam. A substantial fraction of Vietnam's pig industry is now based on imported genetic material (Tisdell et al., 2001). Furthermore, in order to continue with the advances made and to prevent inbreeding further imported genetic material will continue to be introduced. All this means that the local Vietnamese breeds will be diluted with foreign high performing breeds to produce pork. This is mainly because of the high returns obtained from the transfer of genetic material into Vietnamese native stock. A cost-benefit analysis conducted shows the high returns from the technology transfer of pig genes from Australia to Vietnam. This is shown in Table 1.

Table 1:

Benefit-Cost Indicators of Genetic Transfer from Australian to Vietnamese breeds

Component and Assumptions		Benefit-cost indicators		
		NPV ($)	**EIRR (%)**	**B/C**
GENETICS				
1.	**Extra value of slaughter pigs only**			
1.1	5% price premium	249,242,785	1,459	234
1.2	**10% price premium**	**376,960,828**	**2,187**	**354**
1.3	20% price premium	632,396,911	3,643	593
2.	**Extra value of slaughter pig plus extra reproductivity of sows** • Increase in surviving slaughter pigs per sow per year from 14 to 16			
2.1	5% price premium	325,861,896	1,896	306
2.2	**10% price premium**	**457,229,022**	**2,644**	**429**
2.3	20% price premium	719,963,286	4,142	675
	• Increase in surviving slaughter pigs per sow per year from 16 to 18			
2.4	5% price premium	310,324,587	1,807	292
2.5	10% price premium	440,951,732	2,552	414
2.6	20% price premium	702,206,021	4,041	658

Note: Details for the above calculations can be found in Tisdell et al. (2001). The most likely values are in bold. The bulk of the economic benefits from the genetic component of genetic infusion results from improvements in the quality of Vietnamese pork. Furthermore, other economic benefits are from weight gains by pigs and from greater reproductive performance from the use of foreign (Australian) genes.

Because of the high returns of the new breeds the replacement of local breeds with foreign breeds or crosses may also occur at village level. This has already happened in some villages in Vietnam (Tisdell et al., 2003). The process will accelerate with government assistance and as time passes it is likely that local breeds will disappear because of the superior performance of the introduced genes. Furthermore, it is likely that the government will promote such technology because of the government's objective of increasing pork production and also because of the hope of exporting pork in the future. This is especially so with the production of leaner meat brought about by the introduction of new genes. However, it is true that introduced breeds require more husbandry and specialised inputs than traditional breeds. Therefore, introduced pig breeds may not be ideal at the village level.

Once new technology is introduced and when there are perceived economic benefits, the new technology is likely to spread and become the dominant one. A good example is the introduction of HYVs to South Asia in the 1960s. Because of the large increases in production and productivity arising from the new technology, farmers soon adopted it. This technology was also heavily promoted by the respective governments on a large scale with the provision of the high yielding seeds and necessary inputs (including irrigation) and creating the necessary incentives.

In such situations, it becomes increasingly harder for farmers not engaging in such technology to resist change. This is mostly because of the large economic returns generated from the new technology. As a result, by the early 1990s the spread of HYVs in countries such as Sri Lanka was complete and other countries had an adoption rate as much as 95% (Wilson, 2000).

The concentration of production which results from selective genetic material has no doubt increased production and productivity and also lowered costs. However, such a production process has also led to an increasingly 'path dependent' production system mainly because of the lock in aspects involved. This aspect will be dealt with in the next section in relation to the effects such dependence has had on breeds that are left out of specialised commercial production.

ENVIRONMENTAL AND CONSERVATION IMPLICATIONS OF CONCENTRATED PRODUCTION

The effects of path dependence on breeds have been highlighted by Swanson (1995). One of the problems of a ‘path dependent’ evolutionary system is its heavy reliance on a limited gene pool. This not only makes it more vulnerable to collapse with heavy economic losses but also leads to loss of breeds (plants and livestock). First, as concentration of production intensifies, leading to path-dependent systems (Swanson, 1995), breeds that were earlier used (eg. ‘all rounds’) as shown in Figure 1 are likely to disappear (Tisdell, 2003). This is because breeds that cease to be used, have low economic value. Such breeds (overtime) will also become unattractive to subsistence and semi-subsistence farmers. This is because this form of production is overwhelmed by the lower costs of production by the specialised system of production. It displaces subsistence forms of production in a similar way to that which displaced artisans. Furthermore, the process of breed selection and replacement may be influenced by government policies which actually may introduce such technology to subsistence farmers. Foreign aid may also promote the spread of certain high yielding breeds that can displace low yielding, but ‘all round’ breeds.

Technological advances will also accelerate the loss of breeds by increasing substitutability. Motorisation, tractorisation, high labour costs, cheaper chemical fertilisers, changes in cultural values affect the demand for ‘all round’ breeds. Changes in incomes and tastes also affect the demand for local ‘all round’ breeds. For instance an ‘all round’ pig breed producing pork with a higher fat content will become less attractive than a purpose bred pig that produces leaner meat. Such trends are being witnessed in Vietnam (Tisdell et al., 2003).

Continuing research and development on selected breeds to increase their production and productivity and improve certain attributes (eg. to produce leaner meat) further accelerates the path dependence process favouring only a limited number of breeds. This is because as the gap widens between breeds, those breeds that cannot keep pace will be left behind. These breeds are more likely to disappear because of the low economic value placed on them.

Only specialised breeds will remain and that too will be subject to genetic manipulation and development. Such a ‘path dependent’ system is more vulnerable which can result in heavy economic losses, especially because some of the losses (extinctions) are irreversible. For instance, once breeds become extinct, in situations where production systems collapse there is not much option left to revert to the old system of production even if such a costly system is supported. Such a scenario is shown in Figure 2.

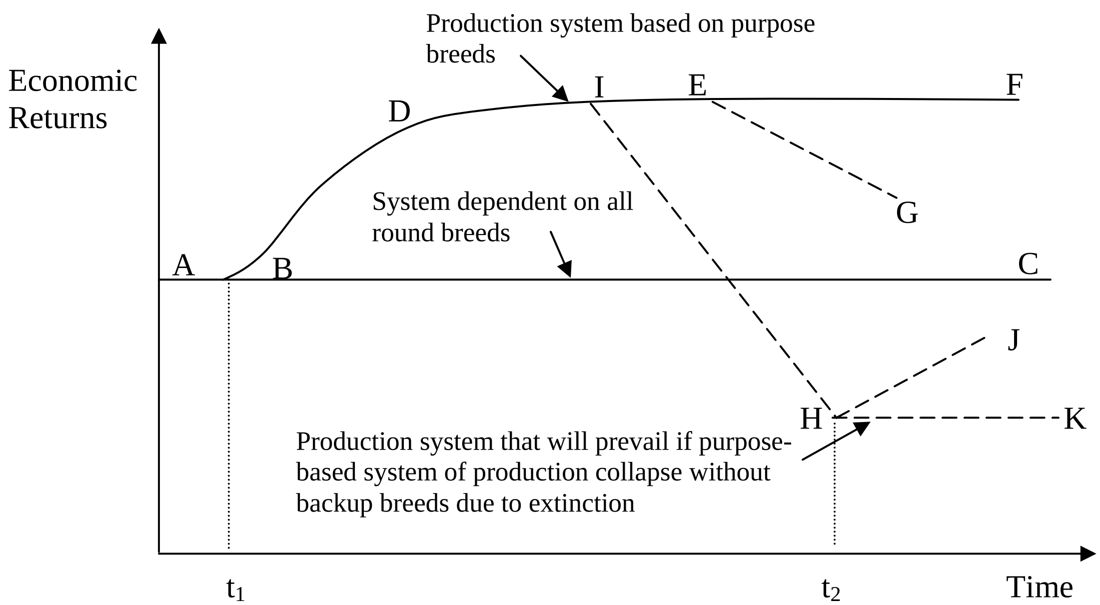

Figure 2: ‘Path dependent’ systems of production can be vulnerable to collapse resulting in heavy economic losses

The line ABC represents economic returns under a subsistence or semi-subsistence system of production where ‘all-round’ breeds are used. This technique is well adapted to the local environment and is sustainable. As globalisation proceeds specialisation of production intensifies to maximise economic returns. In such a situation breeds that are comparatively more efficient in producing more milk or meat or eggs become the preferred choice than the ‘all-round’ breeds. When such a system of production is adopted at time t_1, such a system yields high economic returns as shown by the line BDIEF. Under such a system the economic returns are much larger as what happens under a specialised system of production producing for a globalised market.

This system of production, however, has to be from time to time infused with new genetic material in order to keep producing the large economic returns. If this is not possible, then production may decrease as shown by the line EG. Furthermore, such a system has the potential to collapse through disease or pest attacks. In such a case production will drop, say along the line IH and be at a position H at time t_2. In such an event it may not be able to return to the initial system of production ABC along say, line HJ if extinction of breeds which are essential for this process has occurred. In such a case, production will have to take place with the remaining breeds such as along HK where the economic returns are lower than the ‘all breeds’ form of production which is shown by line ABC. As Hammond (1999); FAO (2000); Cicia, et al. (2003), point out there is no doubt that loss/erosion of genetic material will result in irreversible damage for all generations which will be accompanied by loss of potential market values and environmental functions. In such a scenario, it may well be that the net discounted economic welfare is lower for the new technique than for the old. Conway (1985, 1987) was one of the first writers to discuss this problem of agricultural sustainability.

Hundreds of breeds (livestock and plant) are known to have either become extinct or are on the road to extinction mostly as a result of specialisation of production and concentration of genetic material worldwide. According to FAO statistics, 10% of the world’s livestock have already become extinct and another 20% are facing extinction (FAO, 2000). The highest rates of extinctions have occurred in Europe and North America where concentration and specialisation of production based on narrowing of genetic material have been highest. This trend is spreading in other continents as globalisation proceeds. For instance, if the dilution of breeds continues in Vietnam it is inevitable that pure local Vietnamese breeds such as the Mong Cai will become a casualty of producing for large markets at low costs. Table 2 shows the extent of the problem.

Table 2:

Status of livestock breeds of the world in 2000

Region	Extinct breeds (%)	Breeds at risk (%)	Breeds not at risk (%)	Unknown breeds (%)
Europe	18	40	31	11
North America	18	29	20	33
South and Central America	08	19	41	32
Africa	05	12	49	34
Asia and the Pacific	05	12	49	34
Near east	04	07	42	47
World	10	20	39	32

Source: FAO (2000)

As can be seen from Table 2, the percentage of breeds that are at risk of extinction in Europe and North America where globalisation of production is at its highest. Extinction of breeds is more than half the breeds not at risk for the same two continents. In other continents where globalisation and economic development are still at a lower level, fewer breeds have become extinct or at risk of extinction. However, this will change as globalisation of production proceeds in these continents as highlighted in Figure 1.

Although many factors can account for the disappearance of breeds or bring them close to extinction, Cicia et al. (2003) point out that the main reasons are the 'well-known failures of markets and institutions to provide optimal signals to atomistic decision makers'. With regard to Europe the main causes cited by Cicia et al. (2003) are:

(a) The selection of only a few, highly-productive breeds as demonstrated in Figure 1.

(b) The substitution of animal labour with machines. This is linked, for instance, to intensification of production and reducing costs as explained earlier in the paper.

(c) The growing trend of farm abandonment. This is linked to subsistence/small scale producers not being able to keep pace with specialised forms of production which sell their goods at lower prices.

Similar trends, possibly on a much larger scale, have occurred or are occurring with plant breeds worldwide.

In addition to the disappearance of breeds (genetic erosion), the ‘path dependent’ systems it creates may also cause environmental and health problems. For instance with HYVs, the system of high production is dependent on the use of high use of inputs such as pesticides, fertilisers and irrigation. The continued use of these inputs overtime and in large quantities not only affects the physical environment but also lead to increases in pest attacks and disease outbreaks (Wilson et al., 2001).

This creates further path dependent systems. As Tisdell (1991) demonstrates, when chemical agricultural systems are adopted, agricultural yields or returns become dependent on them despite the very high costs and thus impose an ‘economic barrier’ to switching to organic systems. In short, agricultural practices tend to become ‘inclined towards’ such systems once they are adopted despite being unsustainable (Tisdell, 1991; Tisdell, 1993).

Awareness of the problem of genetic erosion is growing (FAO, 2000) and Cicia et al. (2003) state that the demand is increasing for typical products derived from local breeds facing extinction. This form of production only caters to niche markets and hence, may be insufficient to save breeds though occasionally some breeds are saved because of ‘special qualities that appeal to niche buyers’ (Tisdell, 2003, p.370). Policymakers in industrialised countries (eg. The European Union) are also taking action but the money set aside for the conservation of breeds with low economic values is negligible. For example, a study by Marino (2001) cited in Cicia, et al. (2003) shows that the amount of resources spent for safe-guarding biodiversity accounts only for less than 0.5% of the total financial resources invested in the Italian regions in agro-environmental policy. Hammond et al. (1995) identify the main causes for biodiversity decline and they include economic reasons, technological factors, political and natural events. As correctly pointed out by Gollin et al. (2003), low (economic) utilisation of breeds does not imply low value, although it appears that economic use values is one of the driving forces in breed conservation. As Swanson (1999, p.119) notes ‘once again the decline of the breeds is best viewed as the result of a fundamental investment decision’. The best example that can be cited here is the case of the Pentro horse, an endangered Italian breed. Until recently, this breed was reared by private breeders mainly for their meat but the crisis of the equine meat markets has seen a steep decline of this breed to around 150 animals (Cicia, et al., 2003). However, a contingent valuation study conducted by Cicia et al. (2003) show that the non-market values individuals place on this breed alone could justify a conservation policy.

It appears that the threats of genetic extinction are greater for livestock than for plant breeds. This is because of the practical difficulties of maintaining ex situ collections where the costs are high. Gollin et al. (2003, p.360) state that 'it [this cost] may be higher for animals than for plants'. These problems will be greater in developing countries where there is a shortage of funds for conservation purposes. This is a serious situation because of the rapid spread of globalisation to these countries. History will once again repeat itself and not far from now the data shown in Table 2 for continents other than Europe and North America will be altered and become similar to the current situation prevailing in Europe and North America.

CONCLUSION

In the paper it was shown how specialisation of production of commodities in the agricultural sector, in the quest to increase production and lower costs in order to maximise economic returns, leads to the concentration of genetic material (both plant and livestock). In such situations 'all round' breeds are abandoned in favour of breeds that can produce 'larger quantities of one item' such as for instance meat or milk, but not both.

This process is happening worldwide as agricultural production gets more and more specialised. Already, hundreds of breeds have become extinct in developed countries and some other breeds are on the way out. Similar patterns are expected in developing countries as these countries intensify production, accelerate economic growth and as globalisation proceeds. As the case study showed, the native Vietnamese pig stock is rapidly being diluted with foreign genes or displaced by foreign breeds in order to increase production and productivity in the country. As costs of production decrease and the new genes produce leaner pork and other valuable economic attributes (eg. being subject to les stress during transport), foreign breeds are likely to become popular and become the dominant breeds in the pig industry in Vietnam. This is especially so because of the promotion of this technology by the government and donor agencies. This will lead to even more rapid dissemination of genes among the native pig population. Similar processes have taken place with plant varieties in South Asia since the 1960s. Processes such as those witnessed in South Asia and Vietnam will result in continuing loss of breeds where such transformation is taking place in the quest to produce larger and larger outputs at lower costs in a commercialised and a globalised market. These technologies will lead to increasingly 'path dependent' production systems such as what has been witnessed in South Asia and Vietnam. Such production systems are locked into 'choice limited' production systems with heavy reliance on a very limited gene pool while large stocks of gene pools continue to erode away. Heavy reliance on a limited gene pool has the real possibility of a 'production system' collapse with heavy economic losses. What is even worse is that such a system after a collapse may not be fully recoverable because of the irreversibility issues such as extinctions that are taking place. These threats are real and are happening on a global scale and at a rapid pace as countries continuously strive for greater economic prosperity.

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